**REMARKS**

This Amendment is being filed in response to the Office Action mailed on December 16, 2005. All objections and rejections are respectfully traversed.

Amendments to the Specification

The Specification has been amended to correct an obvious error in calculation. No new subject matter has been introduced.

Amendments to the Abstract

The Abstract has been amended to correct a typographical error. No new subject matter has been introduced.

Amendments to the Claims

Claims 1-40 are pending in the application. Claims 1, 4, 21, and 24 are independent claims. Claims 21, 23-28 and 33-40 have been amended to clarify the claims, and are not intended to narrow the scope of the claimed invention. No additional matter has been added. Claims 14 and 34 have been amend to clarify that a target state of charge may be determined as "the average state of charge for the storage units of the string." See Specification at Page 13 lines 18-25.

Claims 1-18 and 21-38 have been rejected under 35 U.S.C. 102(b) as being anticipated by Peter et al., U.S. Patent No. 5,592,067, issued on January 7, 1997 ("Peter").

Claims 19, 20, 39 and 40 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Peter.

Briefly, the present invention teaches a system and analogous method for determining and balancing ***state of charge*** among plural series connected electrical storage units. Specifically, the state of charge is determined by first ***applying a non-dissipative load*** to a selected storage unit. A "non-dissipative load" refers to a device element for current transfer wherein "at least 80% of the energy through that element is conserved." Specification, Page 8,

lines 7 – 14. The system then determines the state of charge from voltage and current data of the selected storage unit. When the state of charge of the selected unit is different than a target state of charge, energy can be transferred between the selected unit and the string of storage units, such that the state of charge of the selected unit converges toward the target state of charge,.

One embodiment of the present invention as set forth in independent claim 1 comprises:

> A method for determining state of charge of plural series connected electrical energy storage units, comprising:
>
> ***applying a non-dissipative load*** to a selected storage unit in a string of electrical energy storage units, resulting in an energy transfer between the selected storage unit and the string of storage units through the non-dissipative load; and
>
> ***determining state of charge*** of the selected unit from voltage and current data of the selected storage unit resulting from the energy transfer.

As exemplified by independent claim 1, the present invention claims a system and analogous method for determining ***"state of charge."*** As described at Pages 8 and 9 of the Specification, the term "state of charge" refers to a measure that characterizes electrochemical state of a cell after a charging or discharging process. State of charge refers to the quantity of charge present in a cell at a given moment as a fraction of the total charge the cell is able to store.

Equalization of cell *terminal* voltage as practiced in the prior art differs significantly from equalization of "state of charge." In prior art techniques, the readily accessible cell terminal voltage is measured and used as an indicator of cell equalization. However, simply measuring cell terminal voltage in order to equalize cells has drawbacks, because cells having the same terminal voltage may not have the same state of charge.

Cell terminal voltage provides an unreliable measure of state of charge when the string of cells is either providing current to an external load (e.g., hybrid electric vehicle motor) or receiving current from a charging source (e.g., vehicle motor acting as a generator to provide braking action). If the cell string is at rest and neither supplying load current or receiving charging current then cell terminal voltage is equal to cell *internal* voltage which can be used to assess state of charge. However, when cell string load or charging current is flowing, the terminal voltage is lower or higher than the cell internal voltage respectively because of voltage developed across the cell impedance due to the load or charging current flow through it. If two cells have identical state of charge but different impedances, the cells will manifest different terminal voltages when load or charging current is present. If a cell balancing system then

equalizes those terminal voltages, it will create an imbalance in the state of charge where one did not previously exist. Because quite small voltage differences correspond to very significant state of charge differences, failure to correct for impedance effects can produce large cell balancing errors. Therefore, the use of "state of charge" accounts for the internal impedance of cell, allowing for cell balancing during charging and discharging conditions which prevail in practical applications, e.g., equalization of cells in a hybrid electric vehicle or laptop computer battery pack.

According to particular embodiments of the invention, both cell terminal voltage and cell current, are measured under load to enable computation of compensation for the current induced voltage drop or rise across the cell impedance. The state of charge may then be equalized by correcting for the voltage difference that is due to the load and impedance differences and then comparing voltages of individual cells.

## I. <u>The Rejection Under 35 U.S.C. 102(b)</u>

Claims 1-18 and 21-38 were rejected under 35 U.S.C. 102(b) as anticipated by Peter. The Examiner has cited Peter as disclosing a "charge equalizer having, *inter alia*, a plurality of cells, a charge controller for distributing the charge among the cells through a non-dissipative load (phantom modules) until a threshold target is reached. Converters are used to up-transfer or down transfer the charges through a series of switching topologies."

Peter teaches a switching topology that equalizes pairs of individual module voltages in a multiple module battery pack during recharging. Two adjacent module voltages in a string are compared. When the voltages are not equivalent, switched mode converters redistribute charge between the two modules to equalize voltage.

Peter does not disclose the claimed invention in at least three significant respects: (1) Peter relates to cell terminal voltage equalization, not equalization of *state of charge*; (2) the "phantom module" discussed in Peter is not equivalent to a "*non-dissipative load*" of the present invention; and (3) Peter does not determine any measure from a selected unit, and in particular does not *determine "the state of charge of the selected unit from voltage and current data of the selected storage unit resulting from the energy transfer."*

Peter does not relate to the measurement of state of charge. Peter equalizes cell terminal voltage. As discussed above cell terminal voltage is not a reliable indicator of state of charge when the cell string is delivering current to a load or receiving current from a charging source, and equalizing cell terminal voltage is not sufficient.

In citing Peter, the Examiner equates the claimed term "non-dissipative load" with Peter's "phantom module." However, the term "non-dissipative load" refers to a device element for current transfer wherein "at least 80% of the energy through that element is conserved." Specification, Page 8, lines 7 – 14. Examples of a "non-dissipative load" might be an intermediate energy storage buffer for subsequent charging of the string of cells or an individual cell. Specification, Page 9, lines 9-12. By applying the non-dissipative load to the selected storage unit, a measurement of the state of charge can be achieved under load, taking into account measurement of cell voltage combined with cell impedance and current. Because impedance can vary from one cell to the next, especially as cells age, its effects must be accounted for when attempting to equalize state-of-charge amongst cells. On the other hand, Peter's "phantom module" refers to a reference voltage used to facilitate charge transfer from an overcharged cell to its adjacent cell. Col. 4, lines 27- 64. The requirement for this phantom module and its functionality is peculiar to a circuit architecture and control policy which are different from an architecture of the present invention.

The present invention determines the state of charge of a selected unit from terminal voltage and current data of the selected unit. Peter does not even determine terminal voltage of a selected storage unit. Peter does not determine any measure from an individual unit. Rather, the circuit in Peter senses voltage inequality between a pair of modules. Col. 3, lines 47-62.

With respect to the independent system claims of the present invention, claims 21 and 24 both positively recite a controller. A recited objective of Peter "is to provide a system for accomplishing the foregoing objectives without microprocessor or other centralized control." Col. 1 lines 52-54. Because the circuit topology of Peter was designed to avoid microprocessor control, Peter is unable to perform the stated objective of the present application – determining state of charge of plural series connected electrical energy storage units through measurements of voltage and current of selected storage units. Therefore, Peter does not teach the controller of claims 21 and 24.

Further, the Examiner's characterization of Peter's distribution of "charge among the cells" does not accurately reflect the differences between Peter and the present invention's claims, such as claim 4, involving the transfer of energy "***between the selected unit and the string of storage units.***" The circuit topology of Peter requires the transfer of charge from cell to cell. Col. 3, lines 47-52. The structural limitation of Peter precludes it from a cell to string transfer or a string to cell transfer as recited in claims 4-6, 15, 18-20, 24-26, 35, and 38-40 of the present invention.

Applicants respectfully submit that Claims 1-18, and 21-38 are not anticipated by Peter, and thus are in condition for allowance.

## II. <u>The Rejection Under 35 U.S.C. 103(a)</u>

Claims 19, 20, 39 and 40 were rejected under 35 U.S.C. 103(a) as anticipated by Peter.

Specifically, the Examiner states that one or ordinary skill in the art would have provided a timed charge/discharge circuit at the time the invention was made.

To establish a prima facie case for obviousness under 35 U.S.C. § 103(a), the Examiner must not only demonstrate that every claim limitation is taught or suggested by the cited references, but also that a motivation to combine such references is suggested by the prior art. See In re Fine 837 F.2d 1071, 1074, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). The Examiner may not resort to speculation, unfounded assumption, or hindsight reconstruction in the factual basis for rejection. See In re GPAC, Inc., 57 F.3d 1573, 1582 (Fed. Cir. 1995) (finding rejection by Board of Patent Appeals under § 103 as "conclusory" and "lack[ing] the factual basis required"). Nothing in Peter teaches, suggests, or provides any motivation for the use of a timed charge/discharge circuit in combination with the circuit in Peter.

The Examiner's citation to *In re Leshin*, 125 U.S.P.Q. 416 (C.C.P.A. 1960) is not appositive. *In re Leshin*, stands for the proposition that the selection of a known material based on its suitability for its intended use would support an obviousness determination. However, as mentioned above, Peter does not teach, suggest or provide any motivation for the "intended use" of a timed circuit.

In any event, because Claims 19, 20, 39 and 40 are dependent on allowable claims, they too are allowable.

Information Disclosure Statement

Information Disclosure Statements (IDS) were filed on July 1, 2004 and October 10, 2004. A Supplemental IDS is being filed concurrently herewith. Entry of the IDSs is respectfully requested.

## CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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